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A COMPARISON OF POSTMORTEM CORONARY ATHEROSCLEROSIS FINDINGS  
IN GENERAL AVIATION PILOT FATALITIES

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16. Abstract <p>Recognition of medical risk factors is of paramount importance to the Federal Aviation Administration (FAA) with regard to the agency's primary mission of insuring air safety.</p> <p>The autopsy reports of 710 pilots involved in fatal general aviation accidents and received by the FAA for the years 1980-82 were reviewed to appraise the age-specific prevalence of coronary atherosclerosis among the autopsied group and compare findings with those of an earlier study of a similar pilot group. All data were received by the FAA in connection with its responsibilities for medical investigation of accidents.</p> <p>Sixty-nine percent of the autopsies on pilots killed in aircraft accidents indicated some degree of coronary atherosclerosis ranging from minimal to severe. This finding is higher than for a similar group of pilots studied during the years 1975-77. However, only about 2.5 percent of the 1980-82 study group were found to have severe coronary atherosclerosis, compared with 5 percent in the previous study. Prevalence of severe coronary atherosclerosis increased with age from 5.8 per 1,000 for ages less than 40 years to 73.9 for ages 50 years and above, also reflecting lower age-specific rates for severe coronary atherosclerosis than were found in the previous study.</p> <p>Recent emphasis on autopsy format and attention to sudden incapacitation is felt to have resulted in more accurate reporting for recent years. Prevalence of severe coronary atherosclerosis among the recently studied pilot group was less than that observed in an earlier study of a similar group.</p>					
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# A COMPARISON OF POSTMORTEM CORONARY ATHEROSCLEROSIS FINDINGS IN GENERAL AVIATION PILOT FATALITIES

## INTRODUCTION

Cardiovascular disease is the leading cause of death and a significant cause of sudden incapacitation in the United States today. Because sudden incapacitation and sudden death are frequently the first and only manifestations of coronary atherosclerosis, it is of utmost importance, not only to the airman, but to the Federal Aviation Administration (FAA), that cardiovascular disease that could lead to sudden incapacitation be detected early. To that end, FAA screening programs and airman and aviation medical examiner educational programs emphasize the importance of early cardiovascular disease detection. Cardiovascular disease represents the leading cause for denial of medical certification to airman applicants, accounting for over a third of denials for all causes.

Autopsies for 710 pilots involved in fatal general aviation accidents during the years 1980 through 1982 were reviewed to appraise the age-specific prevalence of coronary atherosclerosis among the autopsied group.

## METHODS

Autopsy reports are received, maintained, and reviewed by the Medical Statistical Section, Aeromedical Certification Branch, Civil Aeromedical Institute, Federal Aviation Administration, Oklahoma City, Oklahoma.

For the 3 years studied, 710 pilot autopsy reports were received by the Medical Statistical Section. The total number of fatal aviation accidents was 2,068 for the 3 years 1980-82, which yields an autopsy rate of 34 percent.

There is no reason to believe that the pilots autopsied were a select group. While it is true that a few well-publicized accidents are likely to receive intensive investigation due to air-to-ground communications, the discovery of selected medications at the scene of the accident, and other isolated factors suggestive of in-flight incapacitation, such instances are rare and would have minimal effect on summary data. Some other factors determining whether an autopsy is performed are: the location and circumstances of the accident; availability of a pathologist and facilities; cooperation of the local coroner; and how actively the accident investigation program is pursued in an FAA region.

The autopsies were performed by various medical examiners, hospital pathologists, and forensic pathologists. Reports varied greatly with regard to the length, completeness, detail, and description. These limitations were necessarily considered in the accumulation and presentation of findings.

A three-category classification system based on degree of luminal occlusion was formulated as follows:

1. Grade I : < 33% luminal occlusion
2. Grade II : 33-66% luminal occlusion
3. Grade III: > 66% luminal occlusion

Such terms as "few atheromatous plaques," "no significant atherosclerosis," and "minimal atherosclerosis" were placed into the Grade I category. When a pathologist simply stated "moderate" or "severe" atherosclerosis with no percentage figures, the cases were placed in Grade II and Grade III respectively. Whenever the pathologist used combinations such as "minimum-moderate," "moderate-severe," or "moderately severe" atherosclerosis, the lower category was recorded; e.g., Grade II was recorded for "moderate-severe" atherosclerosis. Similar rationale was used for percentage figures; e.g., 60-70 percent occlusion was recorded as Grade II. In all cases, the percentage figure took priority over the descriptive term; e.g., moderate atherosclerosis with 30 percent occlusion was recorded as Grade I. Recording the lower category and giving priority to the percentage figure resulted in a more conservative estimate of the prevalence of coronary atherosclerosis by grade.

## BACKGROUND

Coronary atherosclerosis is an extremely common form of simple intimal arteriosclerosis in which deposits of yellowish plaques containing cholesterol, lipid material, and lipophages are found within the intima and inner media of large and medium-sized arteries. There appear to be four visual gradings of coronary atherosclerosis: fatty streak, fibrous plaque, complicated lesion, and calcification. The fatty streak is any intimal lesion that is distinctly stained by a fat-soluble dye and does not show any other type of cellular change. The fibrous plaque is a firm elevated intimal lesion that, in the fresh state, is pale gray, glistening, and translucent. A complicated atherosclerotic lesion is one in which there is ulceration, hemorrhage, or thrombosis with or without calcium deposits. And finally, the calcified lesion is an area where calcium deposition is detectable (visually or by palpation) without overlying hemorrhage, ulceration, or thrombosis.

As in most chronic diseases, the etiology of coronary atherosclerosis is complex and multifactorial; the three strongest risk factors for coronary atherosclerosis appear to be hyperlipidemia, hypertension, and smoking. Diet seems to play a major role in the disease process. Diets high in saturated fats predispose to hyperlipidemia; it has been noted that this disease correlates well with the percent of fat intake in the total diet. Recently, the levels of cholesterol in the blood have been definitely associated with an increased risk to coronary atherosclerosis. Prolonged periods of excessive external stress and the increased intake of alcohol are known to raise the level of blood lipids.

Relatively little is known about the contribution of cardiovascular disease to aviation accidents. While the potential for accident outcome has been recognized for some time by the aviation medical community, attention has centered mostly on the commercial or air transport category pilot, and research concerning the general aviation segment of the population has been scarce. Some recent research efforts have, however, focused attention on the significant potential for interaction between existing cardiovascular disease and aircraft accidents (1-8). Pettyjohn and McMeekin found coronary artery disease present to some extent at autopsy in about 87 percent of a 20- to 34-year-old military pilot group with 17 percent classified as moderate and severe (7). Mason's study of preexisting disease and aircraft accidents among United Kingdom aviators found a prevalence of coronary artery disease amounting to 62 percent for a group of British military and civilian pilots

killed while flying, with 24 percent classified as having more than 50 percent luminal restriction (4). In a later article, Mason discusses some interactions between trauma and previous disease that may present difficulties in interpretation with specific reference to coronary disease. Mason points out that severe cardiac damage, a frequent feature of aircraft accidents, may have resulted in conservative interpretation and underestimation of the importance of coronary disease in fatal general aviation accidents (5).

Of the 710 autopsied airmen, 112 could not be classified as to presence or absence of coronary atherosclerosis due to incineration or traumatic destruction of the heart. After removing these 112 "unknown" cases, no coronary atherosclerosis was found in 30.9 percent of the remaining autopsied cases. The prevalence of coronary atherosclerosis to any extent, regardless of how minor, among those airmen who came to autopsy as a result of a fatal general aviation aircraft accident during the years 1980-82 was 69.1 percent. This finding is higher than for a similar group of pilots studied during the years 1975-77 (see Figures 1-3 and Tables I-III)(2).

Severe coronary atherosclerosis, implying at least a two-thirds luminal narrowing, was found in 2.7 percent of the cases (or an average of five cases per year). This is about half the rate observed in the previous study. Obviously, these prevalence findings are of the greatest concern since they represent those most likely to have been subject to sudden incapacitation. However, positive statements regarding sudden incapacitation due to cardiovascular disease were noted in only six instances, or about two per year. The age-specific rates of severe coronary atherosclerosis at autopsy found among the group of airmen studied yield results consistent with previous findings, but different in some important respects. Prevalence of severe coronary atherosclerosis increased with age from 5.8 per 1,000 for ages 39 years and under to 73.9 for ages 50 years and above, also reflecting lower age-specific rates for severe coronary atherosclerosis than were found in the previous study. Recent emphasis on autopsy format and attention to sudden incapacitation is felt to have resulted in more accurate reporting for recent years. The biggest increase between sequential age intervals is observed between ages 40-49 and 50-59, where an approximate fourfold increase is seen. This is different from the previous study, where the biggest increase was seen to occur between ages 30-39 and 40-49, which would be more consistent with known patterns of substantial increase in the incidence of cardiovascular disease beginning at age 40.

## CONCLUSIONS

While the findings of this study are indicative of a continued serious public health problem with cardiovascular disease in the United States population, it is noteworthy that prevalence of severe coronary atherosclerosis observed in the FAA autopsied cases studied is less than what has been observed in other aviation groups studied as well as a previous FAA study. Continued vigilance is obviously called for in screening and in education of airmen and aviation medical examiners. However, it seems unlikely that the low prevalence of severe coronary atherosclerosis could be reduced significantly by the addition of classical noninvasive diagnostic techniques, given the recognized problems of these procedures with regard to sensitivity and specificity.

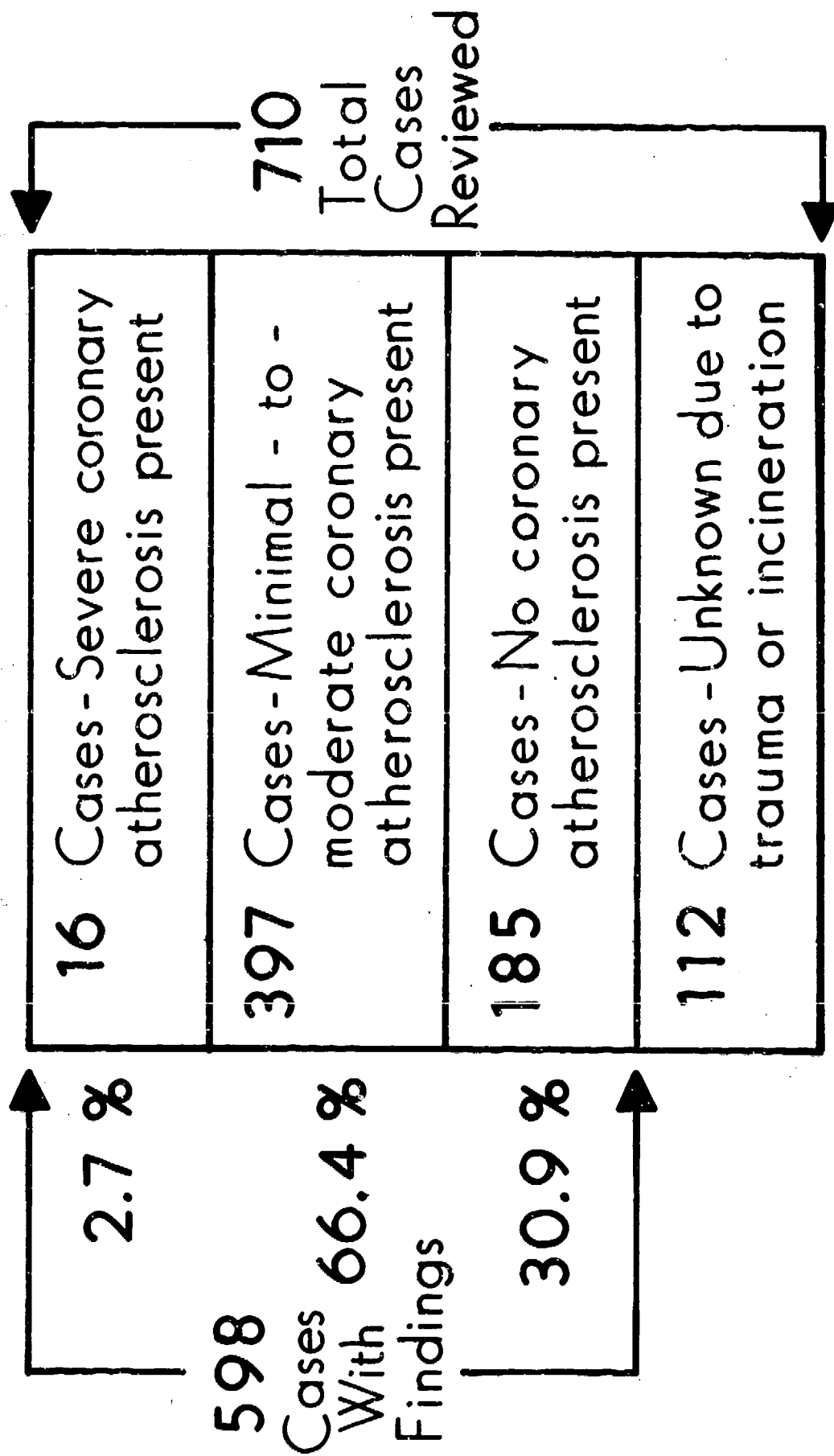


Figure 1. Postmortem coronary atherosclerosis findings in general aviation accident pilot fatalities 1980-82.



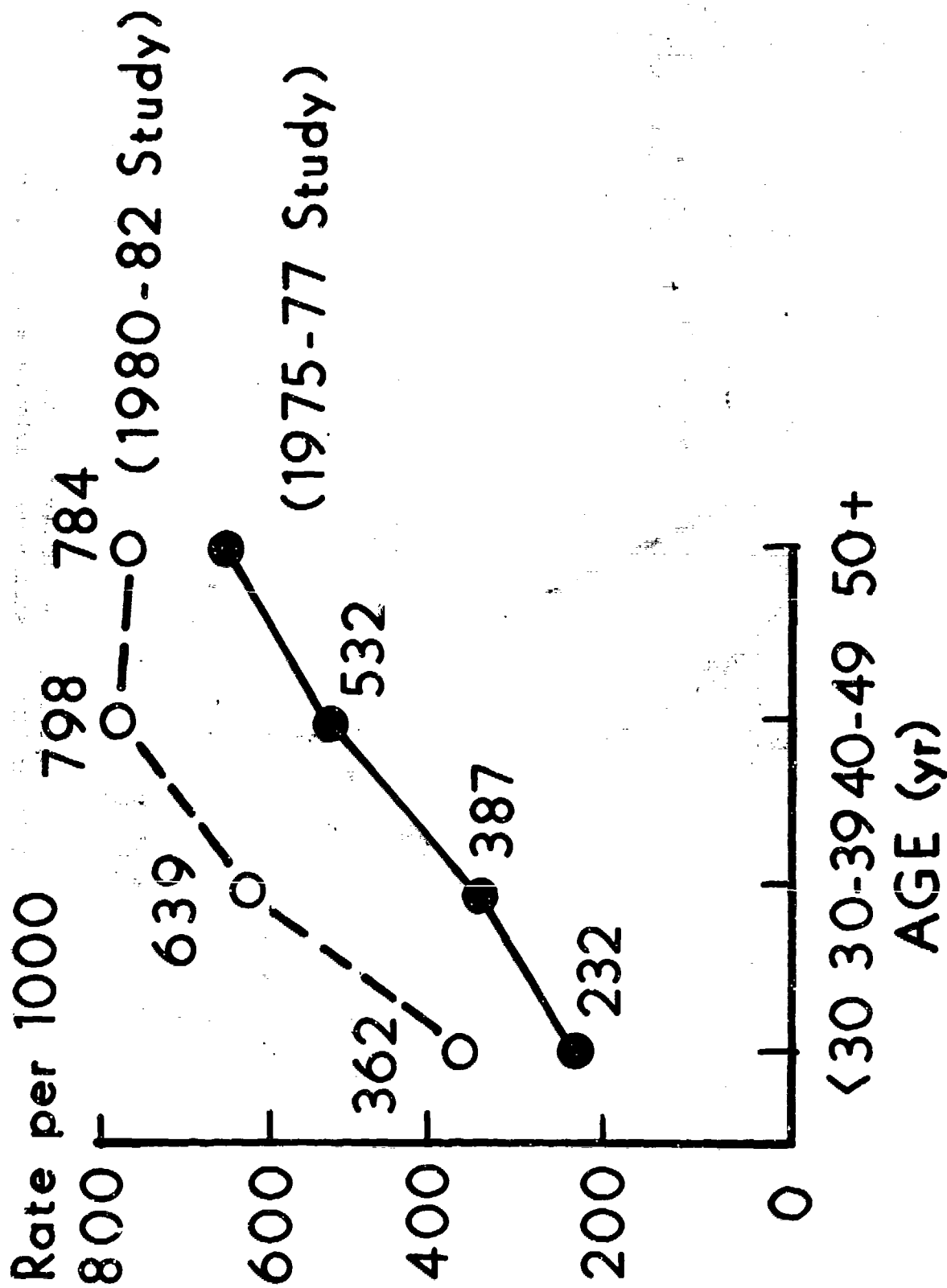


Figure 2. Age-specific rates of minimal/moderate coronary atherosclerosis among 1975-77 and 1980-82 fatal general aviation accident pilots.

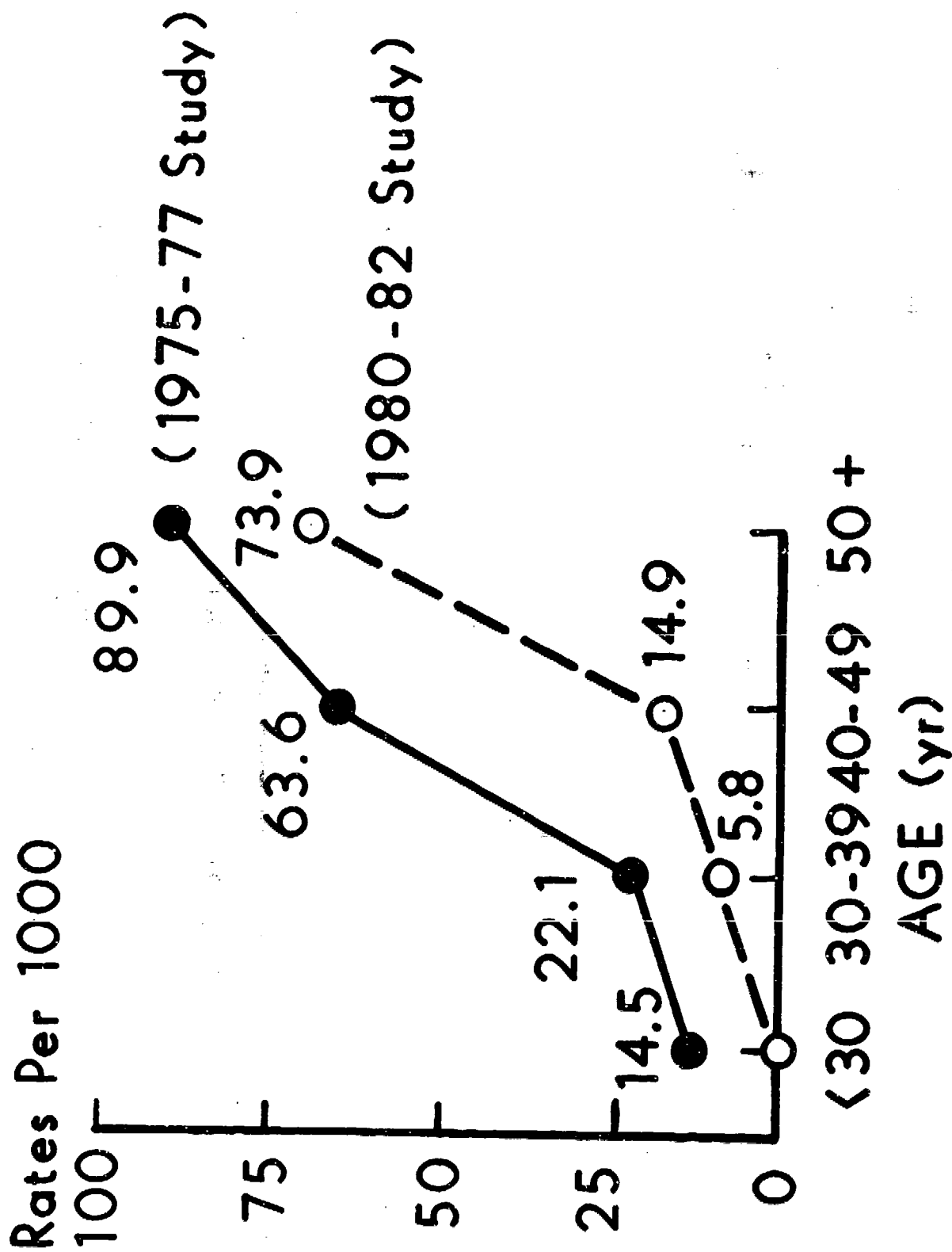


Figure 3. Age-specific rates of severe coronary atherosclerosis among 1975-77 and 1980-82 fatal general aviation accident pilots.

Table I  
AGE DISTRIBUTION OF 1980-82 FATAL GENERAL AVIATION  
ACCIDENT VICTIMS WITH AND WITHOUT CORONARY ATHEROSCLEROSIS

Age Group (yr)	No Coronary Atherosclerosis Present		Minimal to Moderate		Severe	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
29 & under	74	40.0	42	10.5	0	0.0
30-39	61	33.0	110	27.7	1	6.2
40-49	25	13.5	107	27.0	2	12.5
50 & above	25	13.5	138	34.8	13	81.3
TOTAL	185	100.0	397	100.0	16	100.0

Table II  
DISTRIBUTION OF CORONARY ATHEROSCLEROSIS  
BY DEGREE OF INVOLVEMENT, 1980-82 FATAL  
GENERAL AVIATION ACCIDENT VICTIMS

Degree of Involvement	Frequency	Percent
None	185	30.9
Minimal to Moderate (Grades I & II)	397	66.4
Severe (Grade III)	16	2.7
Total Cases With Findings	598	100.0

Table III  
AGE-SPECIFIC RATES OF SEVERE CORONARY  
ATHEROSCLEROSIS AMONG 1980-82 FATAL  
GENERAL AVIATION ACCIDENT VICTIMS

Age Group (yr)	Rate per 1,000
29 & under	0
30-39	5.8
40-49	14.9
50 & above	73.9

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